

INTERNATIONAL

PARTNERSHIPS IN EMERGING GLOBAL MARKETS

global environment

PROGRAM AREAS

- Brazil
- India
- Ukraine
- Poland
- Middle East



economic growth

WORKING TO ENSURE A CONTINUING AND GROWING WORLD MARKET FOR U.S. TECHNOLOGIES, DOE'S INTERNATIONAL PROGRAM HELPS PROMOTE ADVANCED POWER GENERATION SYSTEMS ABROAD.

INTRODUCTION

TACKLING GLOBAL ENERGY ISSUES OF THE 21ST CENTURY

Worldwide, the demand for power is increasing exponentially. The global market for electric power systems has been estimated at \$2,279 billion (1993 dollars) between 1995 and 2010, and over half this investment will be for coal-fired units. At the same time, the energy sectors of many countries are undergoing major transformations. Increasingly stringent environmental regulations, growing international concerns over global climate change, and increased competition among fuels drive the need for advanced power technologies that deliver electricity efficiently, cleanly, and economically.

These trends offer great opportunities for clean coal technologies and advanced power generation systems, the wide-scale adoption of which would protect local, regional, and global environments and support the Administration's environmental goals.

STRATEGIES FOR SUCCESS

The International Program in the U.S. Department of Energy's (DOE's) Office of Coal and Power Systems has four major strategies:

- **Provide leadership in international organizations.** Office of Fossil Energy (FE) staff have leadership roles in several international organizations: the International Energy Agency, Latin America Energy Organization, Asia Pacific Economic Cooperation's Regional Energy Cooperation Working Group, United Nations Economic Commission for Europe Clean Coal Technology Initiative, and the World Energy Council.

- **Maximize export opportunities.** The U.S. is the world leader in the development of clean fossil-power technologies. The International Program works to ensure that U.S. companies get a share of the global market for clean power systems, thereby securing jobs, driving economic growth for the U.S., and contributing to global environmental protection.

- **Establish effective partnerships.** Partnerships play an important role in overcoming barriers facing U.S. companies pursuing export opportunities. Such barriers include trade, finance, inadequate understanding of U.S. clean power systems, and unfair competitive trade practices. Through its partnerships, the program facilitates business solutions to remove these barriers.

- **Facilitate electricity transactions across international borders.** The International Program ensures reliability and open-access transmission through border systems. The Office authorizes exports of electricity, collects and analyzes information on international electricity trade, conducts country-specific studies on electric power systems and the construction of international transmission lines, and provides electric power regulatory assistance.

ONGOING ACHIEVEMENTS

Through membership in international organizations, FE staff in the International Program influence policies to help support U.S. foreign policy and energy, environmental, economic, and national security objectives. Such policies can enhance opportunities for U.S. firms to expand into international markets. International agreements are executed with counterparts in key foreign countries that support FE's RD&D objectives, and foreign partners are supported in an advisory capacity as they pursue private power reforms.

To ensure that U.S. companies get a share of the global market for clean fossil power systems, bilateral efforts are ongoing in seven regions: Africa, Eastern Europe, the Pacific Rim, Russia and the Newly Independent States, South Asia and Near East, Western Europe, and Western Hemisphere. In each region, countries are assisted with adapting their power sectors to meet local demands and environmental pressures. This assistance facilitates dialogue between financial institutions and U.S. companies.

BRAZIL

The International Program, through FE's Office of Coal and Power Import and Export (ImEx), has sponsored several conferences and workshops to promote technology advances in Brazil's coal mining and power generation sectors. In addition, it has sponsored trade missions for industry and government where Brazilian participants have benefited by face-to-face discussions of common areas of interest with U.S. business entities. Projections indicate that coal-fired electricity generation in Brazil could increase substantially and require billions of dollars of investment by 2015. The United States is Brazil's largest trading partner and DOE's efforts in the energy field help maintain this position.

INDIA

Since 1982, the Federal Energy Technology Center (FETC) has managed six coal-related projects in India for the U.S. Agency for International Development (USAID). The total value of these projects, including contributions from the various Indian partners, is about \$80 million, with about \$15 million of the total brought to FETC for direct implementation.

Two of these projects have been completed recently: (1) Program for Acceleration of Commercial Energy Research (PACER), which was funded at \$356,000, and (2) U.S.-Asian Environmental Partnership's (USAEP's) Indo-U.S. Coal Preparation and Beneficiation Project, which was funded at \$382,000. The PACER project included engineering and economic analyses by FETC to support development of commercial coal washeries in India. This project has helped open the Indian coal preparation market, which has been valued at over \$4 billion, to U.S. companies and technologies.

The second project supported deployment of an advanced coal-cleaning circuit, based on U.S. technology supported by DOE, at the first commercial non-coking-coal washery in India. The objective of this project is to demonstrate production of coal with less than 30% ash in the 2.5-million-ton-per-year commercial washery. Two U.S. firms, Spectrum Technologies and CLI, have taken equity positions in the commercial washery, and CLI, a U.S. coal preparation design company, has been awarded a \$12-million engineer, procure, and construct contract and a \$4-million-per-year operation and maintenance contract.

The Greenhouse Gas Pollution Prevention Project, initiated in 1995, is funded by USAID and the Indian government at a total of about \$30 million. The Efficient Coal Conversion component of this project seeks to improve the efficiency and environmental performance of existing Indian coal-fired powerplants, while the Advanced Biomass Cogeneration component seeks to promote year-round cogeneration in Indian sugar mills with power export to the grid while using only biomass fuels.

MAJOR EVENTS TO COME

- Additional efficiency demonstration testing at several State Electricity Boards' coal-fired powerplants to increase awareness of greenhouse gas reduction opportunities and other benefits.
- Selection of three or four additional Advanced Biomass Cogeneration demonstration projects for funding.

- Additional training on the merits and operating characteristics of Advanced Biomass Cogeneration powerplants at Indian sugar mills.
- Monitoring, to world standards, of the Advanced Biomass Cogeneration demonstration projects when they become operational, to develop a database on Indian conditions.
- Assessment of advanced DOE technologies (e.g., fuel cells, pressurized fluidized-bed combustion) and recommendations to USAID-India to provide cost-shared pre-feasibility study funding.
- Continued championing of three integrated gasification combined-cycle (IGCC) projects that are under various stages of development in India with USAID and the World Bank/International Finance Corporation.
- Support of a coal-gasification-based plant, possibly with coproduction of chemicals and power.

BENEFITS TO THE NATION

A stronger economy. Increased international technology sales will improve the U.S. economy and increase the number of high-skill jobs for Americans.

Market competitiveness. The program improves the U.S. technological advantage and U.S. competitiveness in the international market.

Energy security. By promoting strategic international collaboration and supporting high-efficiency use of fuel resources, the FE International Program increases U.S. energy security.

Environmental security. A priority of the program is to mitigate the global environmental impact of increased fossil fuel usage by overcoming the obstacles to using clean fossil power systems.

Expanded markets. Facilitating both new market entries and expansion in existing markets, the program develops international markets for U.S. energy-related technologies, services, and energy resources.



Through a recently completed agreement with USAID-India, FETC supported demonstration of a U.S. advanced coal cleaning technology at the commercial Bilaspur Coal Washery in Madhya Pradesh. This 2.5-million-ton/yr washery is being built through a joint venture among Spectrum Technologies of New York, CLI Corporation of Pennsylvania, and Bombay Suburban Electricity Supply of India. Additional site-specific cost-benefit studies have been conducted to support establishment of other coal beneficiation plants in India with U.S. partners.

CUMULATIVE WORLDWIDE ELECTRIC POWER INVESTMENTS BY REGION (1995-2010)
(IN BILLIONS OF DOLLARS, 1993)

Investment Type	North America	Latin America	Western Europe	China	OECD Pacific Rim	East Asia	South Asia	Central and East Europe	Newly Indep, States	Middle East	Africa	World Total
Generation												
Solid Fuel	94	22	102	222	51	100	71	19	24	2	27	734
Natural Gas	32	23	89	1	14	41	13	10	33	27	15	298
Oil	1	8	1	0	0	1	1	7	2	2	6	29
Nuclear	6	3	8	18	39	21	6	3	26	0	0	129
Hydro/Renewal	17	52	15	67	5	6	48	5	13	3	5	235
Subtotal	149	108	215	308	108	169	139	44	98	34	54	1,426
Other												
Transmission	14	42	20	31	10	28	23	3	14	4	12	200
Distribution	54	36	78	84	39	61	60	11	30	10	19	480
General	14	17	20	43	10	17	21	6	14	5	7	173
Subtotal	82	94	118	159	59	105	103	19	58	18	38	854
Total	231	202	333	467	167	275	242	63	156	52	91	2,279
Annual Average	15	13	22	31	11	18	16	4	10	3	6	152

Source: Resource Dynamics Corp. estimates based on EIA's 1995 World Energy Outlook, Capacity Constraints Scenario, base case.

- Continued technical assistance for Advanced Biomass Cogeneration activities, including an anticipated interest in bagasse gasification for power or liquid fuel production.
- Technical assistance and training to foster "climate-friendly" policies and combat "climate change in cities" in India, two new USAID-India initiatives.

FE has also supported creation of a bilateral Coal Advisory Group, composed of coal and coal technology associations and academics, to advise the Indo-U.S. Bilateral Consultations on issues relevant to the coal industry. This group has the charter to identify topics of interest and propose joint efforts to address those issues. Principal topics of interest include fly ash utilization, coal cleaning, and powerplant efficiency improvements. Secondary issues include coal mine fires and coal-bed methane collection and utilization.

UKRAINE

In 1994, a U.S.-Ukraine Clean Coal Technology Task Force was established to develop a cost-effective approach to upgrading an anthracite-burning powerplant in Eastern Ukraine, Lugansk GRES. Members of the Task Force were drawn from the FE Office, FETC, the Ukrainian Ministry of Energy, and the Ukrainian Academy of Sciences.

The plant uses eight 200-megawatt (MW) slagging pulverized-coal combustors that were installed in the 1960s. While the units have been heroically maintained by plant staff with few resources, the equipment is well beyond its design life and is worn out. The boilers have been derated to 145 MW. In addition, coal quality has deteriorated since the units were put on line. They were designed for use with

a low-grade anthracite having an ash content in the range of 18% to 20%. They have operated recently with coal that contains 30% to 37% ash. About 30% of the calorific feed to the boilers must be supplied by oil or gas to compensate for the poor coal and deteriorated boiler equipment.

Several approaches were used in devising a plan for upgrading Lugansk GRES. An engineering services company evaluated the plant and designed several alternative approaches for rehabilitating the existing boilers, including one that would increase power output above the nameplate capacity to 230 MW. In addition, they described how twin 60-MW circulating fluidized-bed (CFB) boilers could be installed in existing space to use low-quality coal without support fuel.

A shipment of 160 tonnes of Ukrainian anthracite was sent to the U.S. to test schemes for improving its quality

by washing and for use in a large-scale test burn in a 2.5 MWt CFB boiler at Babcock & Wilcox Company's R&D Center in Alliance, Ohio. Tests with washed and unwashed coal in a pulverized-coal combustor at FETC confirmed the benefits of using cleaned coal for improving boiler performance and reducing the need for support fuel. The CFB test showed that coal could be combusted acceptably with no support fuel.

Economic and financial analyses of several approaches to refurbishing existing boilers and installing new CFB boilers were prepared, and several supporting studies by U.S.-Ukrainian teams evaluated coal and coal-waste sourcing, and the coal-cleaning plants available to Lugansk GRES. The option of shutting down Lugansk GRES and bringing in power from other areas was evaluated and found to be uneconomic.



DOE has conducted a cooperative project with the government of Ukraine and with funding from USAID to strengthen the country's thermal power sector. The project at Lugansk GRES developed a cost-effective approach to upgrading an anthracite-burning powerplant. The incentive was first to aid Ukraine in providing alternative sources of power to the nuclear station at Chernobyl, and second to help Ukraine reduce the amount of imported oil and gas it needs for cofiring with poor-quality anthracite at Lugansk GRES, easing its balance-of-payments problem with Russia.

A NEW ENERGY AND ENVIRONMENTAL TECHNOLOGY CENTER IN BEIJING

China will by 2015 replace the U.S. as holder of the dubious honor of being the largest emitter of greenhouse gases during energy conversion. Coal today provides 75% of China's energy needs and is projected to continue supplying at least 60% through 2050.

As a move both to help reduce global CO₂ emissions and to enhance the adoption of U.S. environmentally superior technologies in China, the U.S.-China Energy and Environmental Technology Center in Beijing was instituted in November 1997. Backed by joint DOE and Environmental Protection Agency funding, it demonstrates a long-term relationship, building on trust, mutual benefits, and goodwill.

Activities are jointly implemented by the U.S. and Chinese governments and conducted by a bi-national team. A Web database already contains more than 1,000 U.S. firms with energy and environmental technology and equipment that can serve the Chinese market. The Center is now conducting joint expert studies on coal liquefaction, IGCC for retrofit and repowering, coal preparation, and superfine coal applications, with plans to investigate applications for fuel cells. One recent agreement negotiated by the Center is between HTI, a New Jersey company, and China's Central Coal Research Institute to conduct a feasibility study on direct liquefaction, an area in which U.S. technology competes with Japanese and German suppliers.

In supporting the new center in China, DOE's International Program is advancing national goals of energy and environmental security and increasing opportunities for clean coal technologies in the global marketplace.

POLAND

In 1989, President Bush pledged that the U.S. government and U.S. companies would help the government and people of Poland to reduce severe air pollution in and around the Polish city of Krakow, the former capital. Krakow's monuments and other historic structures were being ravaged by pollution from uncontrolled coal burning.

Since then, DOE FETC has headed the Krakow Clean Fossil Fuels and Energy Efficiency Program, designed to upgrade boiler houses that provide industrial, commercial, and residential heat, as well as small stoves that fire raw coal for home heating and cooking. This usage, combined with low stack heights at district-heating and industrial plants, has caused substantial sulfur dioxide (SO₂), nitrogen oxides (NO_x), and particulates pollution.

The Krakow program, valued at \$20 million, originally considered five different approaches to pollution reduction:

- Conservation and extension of central-station district heating
- Replacement of coal- and coke-fired boilers with natural-gas-fired boilers
- Replacement of coal-fired home-heating stoves with electric heating appliances
- Reduction of emissions from boilers using coal and coke
- Reduction of emissions from coal-fired stoves in private homes

Eight U.S. organizations are participating through cost-shared cooperative agreements that introduce clean coal technologies and upgraded equipment to the Polish marketplace. The U.S. government contribution is, at most, 50%. In some cases, funding comes from third parties or Polish partners.

Almost all of the companies have secured local Polish partners and formed joint ventures, which are expected to lead to the establishment of permanent businesses after the cooperative agreements are completed.

Technologies that are being pursued include boiler-modification and modernization equipment, novel separators that remove particulate matter, use of cleaned and graded coal for stoker boilers, district-heating extension, district-heating controls, briquettes for home stoves, a micronized-coal-combustion system, and automated boiler-combustion controls.

Financially, the program has been highly successful. To date, \$11 million spent on cooperative agreements has leveraged \$12 million from U.S. participants and their Polish counterparts.

In addition, the program has helped to establish three permanent joint ventures and one licensing agreement, to realign the Eastern European operations of a major U.S. firm, and to expand two Polish manufacturing sites. Coal-fired operations have been upgraded and environmental performance has been greatly improved. For example, because updated controls were installed on five boilers, fuel consumption in one boiler house decreased by 25%. Thirty-seven core separators, which have high efficiencies in capturing particulates, have been installed, and 16 more are in the process of being installed across Poland and elsewhere in Central Europe. A local district-heating system has been modernized and expanded, resulting in 41 MW of coal-fired boilers being retired and coal consumption being reduced by more than 1,300 metric tons per year.

Emissions have declined substantially. Particulate matter has been reduced by 3,924 metric tons per year, SO₂ by 884 metric tons per year, NO_x by 183 metric tons per year, and carbon monoxide by 1,330 metric tons per year.

MIDDLE EAST

Several coal and power systems projects are planned and under way in the Middle East. In Egypt, assistance is being provided to Cairo University and the Ministry of Power in their efforts to prepare a proposal to the U.S.-Egypt Science and Technology Joint Fund. The proposal will look at possible alternative solutions to a lack of adequate power. Egypt identifies two problem areas, which they refer to as areas of "chaotic growth" and "touristic villages," that are not adequately served by the electricity grid. One possible

solution that is being proposed by the University of Cairo is the use of U.S.-developed fuel cells, which can provide high-efficiency power generation with no environmental problems.

In Israel, a proposal has been submitted to the U.S.-Israel Science and Technology Commission, administered by the Department of Commerce, to investigate the efficacy of cofiring coal with municipal and industrial waste. This approach has the potential advantage of both providing additional power and eliminating an environmental problem, because the waste is currently being landfilled at high cost in areas of high alternative-use value.

Additionally, Israel has expressed interest in IGCC for the gasification of refinery residuals and for coal gasification backup to new natural-gas-fired powerplants being built on the Mediterranean coast. The new powerplants would derive their fuel from a natural gas pipeline from Egypt, and the IGCC would provide security backup to

any potential disruption of service. Discussions have been initiated between Texaco and Destec in the U.S., the Israel Electric Corporation, and Israel Refineries, Ltd. An IGCC market study is under way and a trade mission to the U.S. is being scheduled.



Eight U.S. companies have had opportunities to market their environmental technologies and establish businesses in Poland thanks to the DOE-led Krakow Clean Fossil Fuels and Energy Efficiency Program. The program also gathered fundamental information on pollutant emissions and reduction strategies for small-scale Polish boilers and home stoves, making this information available to organizations in the U.S., Poland, and Central Europe. Building upon their successes in Krakow, some U.S. businesses have already made additional sales worth several millions of dollars in Poland, Central Europe, and Russia.